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(71) Applicant: ASEA AB
S-721 83 Västeras(SE)

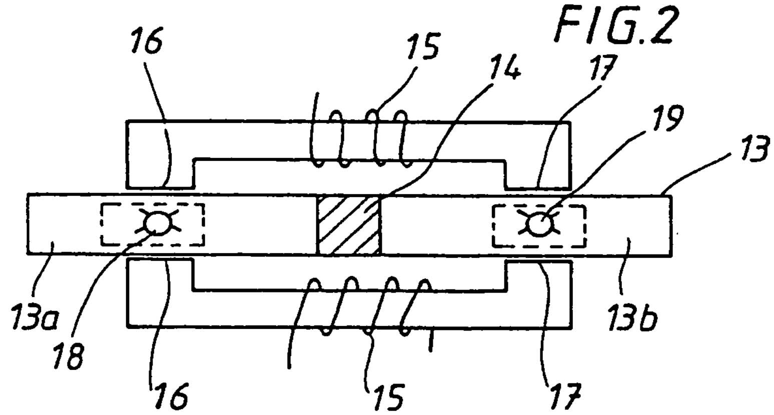
(72) Inventor: Eriksson, Jan, Erik
Laborantgatan 6
S-260 34 Mörarp(SE)

(74) Representative: Boecker, Joachim, Dr.-Ing.
Rathenauplatz 2-8
D-6000 Frankfurt a.M. 1(DE)

(54) Method and device for modifying the metal stream into a continuous casting mold by means of a magnetic field.

(57) Melt fed to a continuous casting mold is slowed and spread by a magnetic field extending across the path (18,19) of the inflowing melt stream. The magnetic field, which is either a static field powered by continuous current (15) or permanent magnets, or an alternating field powered by lo-frequency alternating current (15), is applied at at least two spaced-apart locations (16,17), either in two separated cast strands (13) or at spaced locations across a wide single strand.

FIG.2



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Method and d vic for m difying the metal stream into a continuous casting mold by m ans of a magnetic field

The method relates to method for modifying the stream of molten metal into a continuous casting mold by means of a magnetic field according to the precharacterising part of Claim 1. The invention also relates to a device for carrying out the method. The modification of the flow of the stream of molten metal is preferably intended to slow down the speed of the stream and to split the stream on its impact on the melt already in the mold.

US-A-4,495,984 (EP-A-0040383) discloses a method for stirring the non-solidified parts of a cast strand of metallic material formed in a mold. Melt in the form of a tapping jet enters the mold directly or via a casting pipe. The path of the tapping jet in the mold is arranged to pass through a static magnetic field produced by a permanent magnet or an electric direct current. When the metallic melt passes through this magnetic field, the velocity of the tapping jet is reduced, the tapping jet being divided so that the effect of its impact on the melt in the mold is at least weakened. This prior art method addresses the previous problem that an energetic tapping jet penetrating deeply into the melt in the mold increases the risk of slag particles being deposited along the sides of the strand, thus becoming trapped in the cast strand and making the separation of slag by its drifting up towards the surface of the melt more unlikely.

The invention aims to improving the afore-mentioned prior method and to enable the use of a much simpler and more economic device for carrying out the method.

To achieve this aim the invention suggests a method according to the introductory part of Claim 1, which is characterized by the features of the characterizing par of Claim 1.

Further developments of the method according to the invention are characterized by the features of the additional claims 2 to 9.

A device for carrying out the method according to the invention is characterized by the features of Claim 10.

The invention thus improves the homogeneity of the non-solidified parts of a cast strand being generated in one or more molds from a tapping jet of molten material entering the respective mold directly or via a casting pipe. A magnetic field is arranged to extend across the path of the incoming melt or tapping jet and acts to modify the flow pattern of the material in the tapping jet as it flows into the rest of the melt in the mold.

With the method and device according to the invention a considerably increased production can be obtained from a continuous casting plant in relation to that obtainable with the prior art tapping jet brake. In addition the invention makes possible a more rational way of utilizing the magnetic circuits employed.

The invention will now be described in greater detail with reference to the accompanying drawings showing - by way of example - in

Figures 1a and 1b in schematic sectional views a mold with a partition and provided with two casting pipes,

Figure 2 a sectional view from above an Figure 1a,

Figure 3 an alternative embodiment of a device according to the invention without a partition in the mold

Figures 1a and 1b each show a cross-sectional view through an associated pair of mold parts 13a, 13b located side-by-side in a casting mold 13. The mold 13 is divided by a partition 14 to delimit the mold parts 13a, 13b, but such a partition is not essential, and the invention can be applied as well to one wide mold 13. Two casting pipes 11, 12 lead into the mold parts and conduct melt from a ladle or an intermediate container (not shown) down into the mold parts. Each casting pipe 11, 12 is provided with a central feed channel 18, 19 for the downwardly flowing melt coming from the upstream container. Each feed channel 18, 19 leads to one, two or more outlet channels which may be directed obliquely upwardly, horizontally, obliquely downwardly or vertically peripherally.

Pole pairs 16 and 17 respectively, are arranged on the mold 13, on opposite sides of the longitudinal sides thereof (see Figure 2), and are linked to form a magnetic circuit which creates a magnetic field directed transversely with respect to the flow direction of the tapping jets in the feed channels 18, 19. The pole pairs 16, 17 are intended to split and retard the melt flows defining the tapping jets and prevent, on the one hand, slag deposits collecting on the inside of the solidified shell of melt in the mold 13, and on the other hand, remelting of solidified regions, as well as other associated drawbacks. As will be clear from Figures 1a and 1b, the magnetic fields are arranged to act tranvers s ly to the outlet jets leaving the respective casting pipe 11, 12. However, in the case of direct tapping into the mold, i.a. without the use of a casting pipe, the magnetic field is located to act on the point where the incoming melt stream penetrates into the melt in the mold. The principal directions of the

magnetic fields are clear from the designations ⊙ and shown on the dash lines B in Figures 1a and 1b, and the field-creating means is arranged such that the magnetic fields are directed transversely to each tapping jet.

In the method according to the invention, melt is thus tapped into the mold (with or without the use of a casting pipe), the tapping jet being slowed down by means of the magnetic field and being broadened out (or divided) as is clear from the arrows V_A, V_B, V_C and V_D in Figures 1a and 1b. The pole pairs 16, 17 are suitably arranged such that the lowest velocity of input flow is obtained near the short sides of the mold 13 and/or such that the depth of penetration of the tapping jet or flow into the melt is as small as possible. Adjustments of velocity and direction of flow can be made by means of mutual displacements of the poles 16, 17 in each pair, and/or by means of certain relative angular adjustments thereof. These can be empirically set for each particular case for the purpose of obtaining the lowest melt velocity along the short sides of the mold. This is the most appropriate way of preventing deposits on, or remelting of, the inside of the solidified shell in the mold. The partition 14 used to separate the cast strands, may for example, be a cooled copper body (see Figures 1a, 1b, 2), and the intention of using such a body is to create two separated cast strands. The magnetic circuit, which either contains permanent magnets or iron cored electric coils is connected to the respective pole pairs 16, 17. In the electromagnetic case, one or more coils 15 is/are supplied with direct current to create a static field, or with a low frequency alternating current to create a field alternating in magnitude and direction periodically as a function of time. The frequency used is suitably less than 0.1 Hz, for example 0.01 Hz. Whether the field be static or alternating, its purpose is to bring about a spreading out or diffusing of the tapping jets. The magnetic field strength at the tapping jets can be in the range 1000 to 4000 gauss (0.1 - 0.4 tesla).

Figure 3 shows, in contemplation from above, an alternative embodiment in which a single broad cast strand is fed by two spaced apart tapping jets 20 and 21. No partition 14 is used here, but the principle of spreading and retarding the incoming melt flows in exactly the same in this arrangement as applies in the arrangement shown in Figures 1a, 1b and 2. Thus, in the method according to Figure 3, the melt flows are spread out and braked, and deposits on, and/or melting of, the solidified shell are prevented. The mold is shown at 22 in Figure 3.

The method and the device according to the foregoing description can be varied in many ways within the scope of the following claims.

Claims

1. Method of modifying the flow of a stream of molten metal into the mold of a contrinuous casting plant, which comprises subjecting the stream of molten metal in the mold to a magnetic field **characterized** in that magnetic fields are applied at two spaced-apart locations in the melt.

2. Method according to Claim 1, **characterized** in that the magnetic fields are generated by electric current through at least one electrical coil (15) positioned on an iron core, the poles (16,17) of which direct the field towards the inflowing melt.

3. Method according to Claim 1, **charact rizedin** that the magnetic fields are generated with permanent magnets.

4. Method according to any of the preceding Claims, **characterized** in that the inflowing melt is supplied via casting pipes (11,12) and the magnetic fields are directed to where the melt leaves the casting pipes.

5. Method according to any of the preceding Claims, **characterized** in that the magnetic fields are directed such that the smallest velocity of each stream of molten metal in obtained where the stream is closest to a wall of the mold.

6. Method according to any of the preceding Claims, **characterized** in that two separate cast strands are created side-by-side by dividing the mold, between two incoming melt flows, with a partition (14).

7. Method according to Claim 6, **characterized** in that the partition is a cooled copper body.

8. Method according to any of the preceding Claims, **characterized** in that the magnetic field strength lies in the range 1000 to 4000 gauss.

9. Method according to any of Claims 2 and 4 to 8, **characterized** in that said at least one electrical coil is fed with an alternating current of a frequency less than 0.1 Hz.

10. Device for carrying out the method according to any of the preceding claims comprising at least one open-bottomed mold in a continuous casting machine with or without a casting pipe, means to feed melt to the top of the mold to enter the melt in the mold at two separated tapping points, **characterized** in that at said at least two separated tapping points there are arranged pole pairs (16,17) for the application of a magnetic field at each tapping point transversely to the main flow direction of the stream and that the field-creating magnetic voltage is derived from at least one permanent magnet and/or at least one DC-powered or low-frequency AC-powered electrical coil with an iron core connected to the respective pole pairs.

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FIG.1b

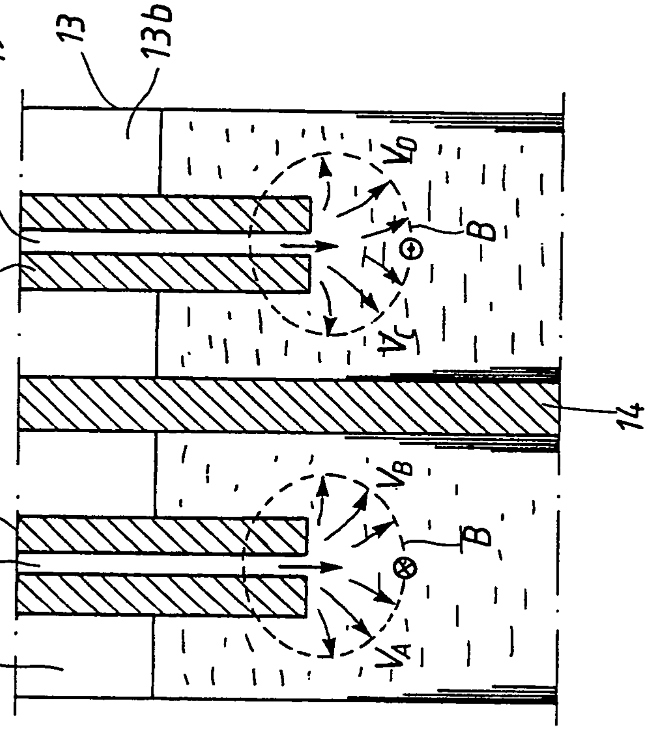


FIG.3

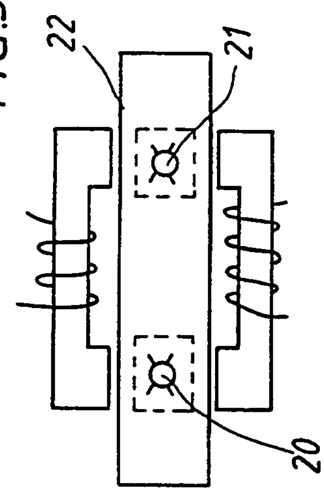


FIG.1a

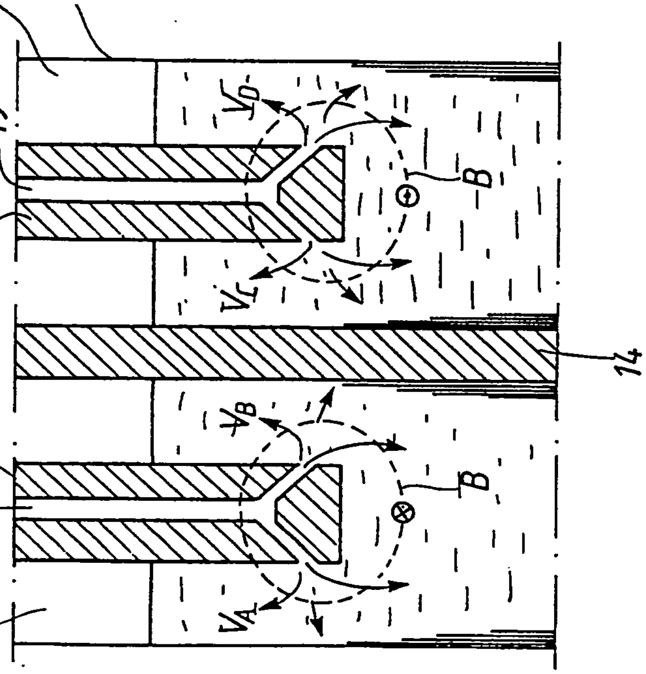
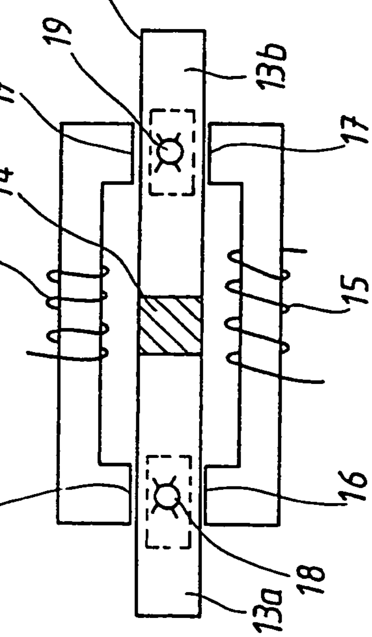


FIG.2



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EUROPEAN SEARCH REPORT

Application Number

EP 87 11 5162

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
D,X Y	EP-A-0 040 383 (ASEA) * Page 5, lines 10-17,29-33; claim 7; figure 5 * ---	1-5,8-10 6,7	B 22 D 11/10
Y	US-A-3 717 197 (STRACK et al.) * Column 2, lines 38-48 * ---	6,7	
X	PATENT ABSTRACTS OF JAPAN, vol. 10, no. 216 (M-502)[2272], 29th July 1986; & JP-A-61 52 969 (NIPPON KOKAN K.K.) 15-03-1986 * Abstract * ---	1-5	
X	PATENT ABSTRACTS OF JAPAN, vol. 8, no. 186 (M-320)[1623], 25th August 1984; & JP-A-59 76 647 (KAWASAKI SEITETSU K.K.) 01-05-1984 * Abstract * ---	1-5	
A	PATENT ABSTRACTS OF JAPAN, vol. 4, no. 183 (M-47)[665], 17th December 1980; & JP-A-55 130 363 (SUMITOMO KINZOKU KOGYO K.K.) 09-10-1980 * Abstract * -----	1,6,7,10	TECHNICAL FIELDS SEARCHED (Int. Cl.4) B 22 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24-02-1988	DOUGLAS K.P.R.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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